REMARKS

Claims 1-20 remain in the application with claims 17-20 being withdrawn from consideration. Claims 1-16 are in original form with claims 1 and 5 being independent.

The present invention is directed toward an improved gas collimater for a kinetic spray nozzle and a nozzle incorporating the same. Kinetic spray systems are known in the art and differ significantly from the older system known as thermal spray systems. Thermal spray systems rely on the melting of a coating material to produce molten coating material which is then directed by a gas stream toward a surface to be coated. The molten material strikes the surface to be coated and adheres as the molten material cools. Kinetic spray systems are just the opposite in that the material to be sprayed onto a surface is never raised to a temperature above its melting temperature, thus, its phase and physical state do not change during the spraying process as in the thermal spray systems. Kinetic spray systems rely on accelerating a coating material to a velocity above a "critical velocity" that is dependent on the material being sprayed, its particle size, and the substrate being coated. Kinetic spray systems rely on accelerating the coating material above the critical velocity such that when it strikes the surface to be coated it plastically deforms without any melting and attaches to the surface to be coated.

As disclosed in paragraph [0003] of the present specification in the prior art it is known that the deposition efficiency of a given particle mixture onto a surface is increased as the main gas temperature is increased. Increasing the main gas temperature decreases its density and thus increases its velocity. The velocity of the main gas varies approximately as the square root of the main gas temperature. Thus, it is known that

deposition efficiency for a given particle can be improved by increasing the main gas temperature.

As discussed in paragraph [0004] of the present specification one of the problems associated with the usual high pressure kinetic spray systems is that the systems tend to clog as the main gas temperature is increased. Thus, there are physical limitations to the ability to increase the deposition efficiency of a given particle by increasing the main gas temperature. As noted in paragraph [0005] of the present specification low pressure systems are an alternative to the typical high pressure kinetic spray systems. One of the difficulties associated with low pressure kinetic spray systems is the asymmetric assimilation of particles into the main gas stream. In addition, both the high pressure and low pressure kinetic spray systems suffer from turbulence of the main gas flow because the main gas goes through a right angle as it is introduced into the converging section of the supersonic kinetic spray nozzle. The gas turbulence significantly reduces the deposition efficiency of the kinetic spray system with a variety of different particles.

In summary, it is known from the prior art that the deposition efficiency of a given particle can be increased by increasing the main gas temperature but there are limitations to this increase. It is furthermore known that high pressure kinetic spray systems have a higher deposition efficiency for a given particle population than low pressure kinetic spray systems. Finally, it is also known that the traverse speed of the kinetic spray system nozzle relative to the substrate has a dramatic effect on the deposition efficiency. The slower the traverse speed the higher the deposition efficiency of a kinetic spray system. The present invention is directed toward overcoming the limitation on deposition efficiency imposed by the limit of main gas temperature and

toward reducing the turbulence effect on the deposition efficiency of a kinetic spray system.

As disclosed in paragraph [0025] of the present specification in the prior art kinetic spray systems the collimater 40 is a disc having a thickness of approximately 1 mm. It is also noted in paragraph [0030] that a similar gas collimater has been utilized in the past in low pressure kinetic spray systems. The gas collimater of the present invention is disclosed in paragraph [0030] and figures 4, 5, and 8b of the present specification. As noted the present invention lies in significantly lengthening the gas collimater to a length of from 10-30 mm and more preferably from 25-30 mm, a 10-30 fold increase over the length disclosed in the prior art. It is additionally preferable that the hydraulic diameter of the holes within the gas collimater be from 0.5 to 5.0 mm. It is also preferable that the ratio of the hydraulic diameter of the holes to the length of the collimater be in a ratio of from 1:5 to 1:50. Finally, it is preferable that the ratio of the total open space in a cross-sectional area of the collimater to the cross-sectional open area of the mixing chamber be in a ratio of from 0.5:1 to 0.9:1.

The Examiner rejected claims 1-3 and 5-10 under 35 U.S.C. § 103(a) as being unpatentable over Van Steenkiste et al. (US Pat. No. 6,139,913) or Popoola et al. (US Pat. No. 6,464,933).

Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching, suggestion, or motivation that would lead one of ordinary skill in the art to combine the references. *In re Sang Su Lee*, 277 F.3d 1338 ; 61 USPQ 2nd. 1430 (Fed. Cir. 2002), citing *Brown & Williamson Tobacco Corp, v. Phillip Morris, Inc.*, 229 F.3d 1120, 1124-25 (Fed. Cir. 2000); *In re Napier*, 34 U.S.P.Q. 2d

1782 (Fed. Cir. 1995). Elements of separate prior patents cannot be combined when there is no suggestion of such combination anywhere in those patents. *Panduit Corp. v. Dennison Mfg. Co.*, 1 USPQ 2[d] 1593 (Fed. Cir. 1987). Virtually all inventions are necessarily combinations of old elements and, thus the notion that combination claims can be declared invalid merely upon the finding of similar elements in separate prior patents would necessarily destroy virtually all patents and cannot be the law under section 103. *Id.* The U.S. Court of Appeals for the Federal Circuit recently made the following statements in *Yamanouchi Pharmaceutical Co., Ltd. v. Danbury Pharmacal, Inc.* 56 USPQ2d 1641, 1644 (Fed. Cir. 2000) concerning the combination of old elements:

> "virtually all [inventions] are combinations of old elements. Therefore, an Examiner [or accused infringer] may often find every element of a claimed invention in the prior art. If identification of each claimed element in the prior art were sufficient to negate the patentability very few patents would ever issue. Furthermore, rejecting patents solely by finding prior art corollaries for the claimed elements would permit an examiner [or accused infringer] to use the claimed invention itself as a blueprint for piecing together elements in the prior art to defeat the patentability of the claimed invention...To counter this potential weakness in the obvious construction, the suggestion to combine requirements stands as a critical safe guard against hindsight analysis and rote application of the legal test for obviousness." [Emphasis added]

Further, when claimed subject matter has been rejected as being obvious in view of a combination of prior art references a proper analysis under section 103 requires a consideration of two factors: [1] Whether the prior art would have suggested to those of

ordinary skill in the art that they should make the claimed composition or device, or carry out the claimed process; and [2] whether the prior art would also have revealed that, in so making or carry out , those of ordinary skill would have a reasonable expectation of success. *In re Vaeck*, 20 USPQ2d 1438 (Fed. Cir. 1991), *In re Dow Chemical Company*, 5 USPQ2d 1529 (Fed. Cir. 1988). Both the suggestion and the reasonable expectation of success must be found in the prior art not in the applicant's disclosure. *Id.*

When analyzing the issue of obviousness, the differences between the prior art and the claims that issue must be ascertained. *Graham v. John Deer Co.* 148 USPQ 459, 467 (Sup.Ct.1996). In conjunction with the first three "Graham factors" personal of the US Patent and Trademark Office should: (1) Determine the "scope and content of the prior art"; (2) Ascertain the "differences between the prior art and the claims that issue"; and (3) Determine the "level of ordinary skill in the art". Official Gazette, 1196 OG 38, March 11, 1997. With respect to the scope and content of the prior art each reference must qualify as prior art under 35 U.S.C. § 102, and should be in the field of the applicant's endeavor or be reasonably pertinent to the particular problem with which the inventor was concerned. *Id.* The mere fact that the prior art can be modified does not make the modification obvious unless prior art taught or suggested the desirability of the modification. *In re Gordon*, 221 USPQ 1125, 1127 (Fed. Cir. 1984).

Obviousness may not be established by hindsight. *Kahn v. General Motors Corp.* , 45 USPQ2d 1608 (Fed. Cir. 1998). Determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention. *In re ATD Corp v. Lydal, Inc.*, 48 USPQ2d 1321, 1329 (Fed.Cir.1998). Combining prior art references without evidence of a suggestion,

teaching, or motivation simply takes the inventor's disclosure as a blueprint for piecing together the prior art to defeat patentabililty-the essence of hindsight. *In re Dembiczak*, 50 USPQ2d 1614 (Fed. Cir. 1999). The prior art must suggest to one of ordinary skill in the art the desirability of the claimed combination. *In re Fromsom v. Advanced Offset Plate Inc.*, 225 USPQ 26, 31 (Fed. Cir. 1985). Good ideas may well appear "obvious" after they have been disclosed after despite having been previously unrecognized. *In re Arkie Lures, Inc. v. Gene Larew Tackle, Inc.* 43 USPQ2d 1294 (Fed. Cir. 1997).

The Examiner admits that neither of the cited references Van Steenkiste et al. or Popoola et al. teach the limitations of the gas flow holes having a length of from 10-30 mm or a hydraulic diameter of from 0.5-5 mm as required by independent claims 1 and 5. The Examiner furthermore admits that none of the references teach that the ratio of the total open space in a collimater cross-sectional area to the cross-sectional area of the mixing chamber is from 0.5:1 to 0.9:1. Likewise, none of the references disclose wherein the ratio of the hydraulic diameter of the holes to the length of the collimater is from 1:5 to 1:50. While admitting all of this the Examiner goes on to state that it would be merely an obvious matter of design choice to configure the device of Van Steenkiste et al. or Popoola et al. with gas flow holes having a length of 10-30 mm, a hydraulic diameter of from 0.5-5 mm, a ratio of the hydraulic diameter to the length of from 1:5 to 1:50 and a ratio of the total open area in a cross-section of the collimater to a cross-sectional open area of the mixing chamber of from 0.5:1 to 0.9:1. The Examiner suggests that the Applicant has not disclosed that having the gas flow holes with a length of 10-25 mm, or the ratio of the hydraulic diameter to the length being from 1:5 to 1:50, or the ratio of the cross-sectional open area to the cross-sectional area of the mixing chamber being form 0.5:1 to 0.9:1, or the hydraulic diameter of

the collimater holes being from 0.5 to 5.0 mm provides any advantage, is used for any particular purpose, or solves any stated problem.

The Examiner is directed to paragraphs [0003] through [0005] of the present specification wherein it discloses the numerous problems with the prior art systems incorporating gas collimaters that are very thin 1 mm discs. To summarize again the problems are low deposition efficiencies that cannot be alleviated by raising the main gas temperature without leading to clogging issues, asymmetric assimilation of particles into the gas stream, turbulence within the gas stream which reduces the deposition efficiency of the system. All of these problems are addressed by the present invention. As for the advantages of the present invention the Examiner is directed to figure 7, figure 9a, and figure 9b. In addition, the Examiner is directed to paragraphs [0035] through [0038] wherein these figures are discussed. A careful review of the data disclosed in these figures makes it clear that the present invention provides significant advantages over the prior art gas collimater that are related to the specifics that are claimed in independent claims 1 and 5.

Referring initially to figure 7 and paragraph [0035]. The results disclosed in figure 7 were obtained using a constant main gas temperature of 800°F, particles of aluminum-zinc-silicon having a particle size range of from 53-106 microns, a constant traverse speed of 2 inches per second, and a constant main gas pressure of 300 pounds per square inch. Reference line 100 in figure 7 shows the results utilizing a prior art high pressure system wherein the collimater is a thin disc of approximately 1 mm in thickness. As expected the results show that as the powder feed rate of the system is increased the loading onto a substrate surface is increased. An example of the nozzle utilized for generating these results is shown in figure 2. Reference line 104 shows the results that are obtained using a prior art

low pressure system as disclosed in figure 3. This is a low pressure system and as expected the mass loading obtained utilizing the prior art low pressure system at a given feed rate is lower than that of the prior art high pressure system as one would expect. In both cases the amount of loading increases as the powder feed rate is increased as expected. What was unexpected is what is disclosed in reference line 102. This represents a gas collimater designed in accordance with the present invention in a low pressure system wherein the collimater has a length of from 10-30 mm, the collimater utilized in this figure had a length of approximately 25 mm, and the gas flow holes had a hydraulic diameter of from 0.5 to 5 mm. It can be seen that at all powder feed rates the present invention gas collimater provided a significant increase in the mass loading onto a substrate obtainable by a given powder feed rate. The Examiner can see by a comparison between reference lines 104 and 102 that the present invention provides a significant and unexpected advantage. As expected and discussed in the specification even with this enhanced deposition efficiency reference line 102 is not as high as reference line 100.

The Examiner is now directed to figures 9a and 9b and paragraphs [0036] through [0038]. All of the data disclosed in both figures was generated utilizing a powder that was an alloy of aluminum-zinc-silicon, sprayed onto aluminum substrate, the powder feed rates were kept constant, the particle size range was from 53 to 106 microns, the gas pressure was 300 pounds per square inch, the powder feed pressure was 350 pounds per square inch and the results disclosed in the figures are the average of twelve runs for each condition. The systems were high pressure systems.

Figure 9a shows the loading onto a substrate of two examples of the present invention versus a prior art system. Bar 118 represents the results obtained utilizing a gas

collimater designed in accordance with the present invention wherein the length was approximately 20 mm and the gas flow holes had a hydraulic diameter of from 0.5 to 5 mm. The results were obtained using a main gas temperature of 700°F and a traverse speed of 4 inches per second. It can be seen that the results are close to 140 grams per square meter of loading utilizing these conditions. This is in comparison to reference bar 122 which represents the prior art system wherein the gas collimater as disclosed has a thickness of approximately 1 mm. The results shown in bar 122 were obtained after raising the main gas temperature to 800°F and lowering the traverse speed to 3 inches per second. Based on knowledge of the prior art it would be expected that increasing the main gas temperature and reducing the traverse speed should lead to a higher loading of the substrate. Surprisingly, the results are completely unexpected in that the loading was significantly reduced compared to bar 118 utilizing the gas collimater of the present invention. In addition, even when the traverse speed is increased from 4 inches per second to 5 inches per second as shown in bar 120 the present invention still results in a significant increase in the loading on the substrate compared to the prior art shown in bar 122.

Examiner is now directed to figure 9b which shows the deposition efficiency of the present invention versus the prior art. Bar 124 is the deposition efficiency of a system identical to that disclosed in bar 118 above, namely a main gas temperature of 700°F and a traverse speed of 4 inches per second. You can see that the deposition efficiency is close to 50% under these conditions. Bar 126 represents a system identical to that disclosed in bar 120 in figure 9a. In the system the main gas temperature was 700°F and the traverse speed was 5 inches per second. Finally, it can be seen that the deposition efficiency of the prior art system shown in bar 128 is less than half that disclosed in either of the prior present

invention systems even though the main gas temperature has been increased to 800°F and the traverse speed has been reduced to 4 inches per second.

In summary the data disclosed and discussed in the present specification makes it clear that the gas collimater designed in accordance with the present invention produces unexpected and significant advantages compared to that found in the prior art. It solves a significant problem in that it enables an operator to utilize a lower main gas temperature while getting a highly enhanced deposition efficiency even at higher traverse speeds. The significance of the advantage provided by the gas collimater of the present invention cannot be over emphasized.

Van Steenkiste et al., which utilizes a gas collimater of the prior art as discussed in the present invention, merely refers to the gas collimater as flow straightener 40. The Examiner is directed to column 3, lines 35-40 and column 3, lines 50-52. There is no discussion, suggestion, teaching or motivation in Van Steenkiste et al. for considering the gas collimater 40 to be a result effective variable on the deposition efficiency of the kinetic spray system as was discovered by the present inventors. Likewise, Popoola et al. is similarly silent as to any effect of the gas collimater disclosed therein 26 on the deposition efficiency of the kinetic spray system. Given that there is no discussion in either of the cited references of the gas collimaters utilized it is unclear how the Examiner can imagine that the present invention which has been shown to provide a significant enhancement in the deposition efficiency of a kinetic spray system would be obvious based on either of the references either taken alone or in combination. Because independent claim 1 and 5 both include numerous limitations not found in nor made obvious in view of either of the cited references taken alone or in combination the rejection of independent claims 1 and 5 and the

claims which depend therefrom under 35 U.S.C. § 103(a) based on the cited references is improper and should be withdrawn.

The Examiner rejected claim 4 under 35 U.S.C. § 103(a) as being unpatentable over Van Steenkiste et al. or Popoola et al. as applied to claims 1-3 and 5-10, further in view of Mochida et al. (US Pat. No. 4,740,408).

As discussed above Van Steenkiste et al. and Popoola et al. taken alone or in combination do not make independent claim 1 obvious. Claim 4 depends from independent claim 1. The Examiner further relies on Mochida et al. as disclosing gas flow holes having a hexagonal shape. The Examiner suggests that based on Mochida et al. changing the shape of the holes would provide an effective gas flow device. The deficiencies of Van Steenkiste et al. and Popoola et al. with respect to the rejection of claim 1 under 35 U.S.C. § 103(a) are not overcome by the disclosure of Mochida et al. Mochida et al. is directed toward a ceramic honeycomb body suitable for carrying catalizers to purify exhaust gas from internal combustion engines as disclosed in column 1, lines 1-10 of Mochida et al. It is not clear how the Examiner would imagine that one of ordinary skill in the art would be motivated to combine any of the shapes for the gas flow holes for the catalytic converters disclosed in Mochida et al. with the gas collimaters disclosed in either Van Steenkiste et al. or Popoola et al. In addition, as discussed above even when combined it would not make it obvious why one of ordinary skill in the art would modify the gas collimater shown in Van Steenkiste et al. and Popoola et al. to have a length of from 10-30 mm, which is 10-30 fold larger than that found in Van Steenkiste et al. and Popoola et al. and all of the prior art references and to change the gas flow holes to have a hydraulic diameter of from 0.5 to 5 mm as required by independent claim

1. Because independent claim 1 includes numerous limitations not found in nor made obvious based on the cited references the rejection of claim 4, which depends from independent claim 1, under 35 U.S.C. § 103(a) based on the cited references is improper and should be withdrawn.

The Examiner rejected claims 11-16 under 35 U.S.C. § 103(a) as being unpatentable over Van Steenkiste et al. or Popoola et al. as applied to claims 1-3 and 5-10 and further in view of Belashchencko et al. (US Pat. No. 5,932,293). With respect to claims 12-16 the Examiner dismissively stated:

> With respect to claims 12-16, at the time the invention was made, it would have been an obvious matter of design choice to a person of ordinary skill in the art to provide different configurations or location of the injector tube, or with different flow rate for the injector tube.

Belashchencko et al. is directed toward a thermal spray system and not a kinetic spray system as is the present invention and all of the other cited references. Applicants assume that the Examiners reference to an injector tube 68 extending into a throat refers to figure 7 of Belashchencko et al. A review of figure 7 and the accompanying descriptive text of Belashchencko et al. reveals that there is no throat disclosed in the kinetic spray system of Belashchencko et al. In addition the injector 68a shown in Belashchencko et al. ends before the end of the converging section of the nozzle and does not extend through a throat as suggested by the Examiner and as required by independent claim 5 of the present application which claims 11-16 depend from. Even when combined with Van Steenkiste et al. and Popoola et al. Belashchencko provides no

motivation for modifying the disclosures of Van Steenkiste et al. and Popoola et al. to extend the powder injector through the throat of the super sonic nozzle and into the diverging section of the nozzle as required by the present claims. As disclosed in the present specification in paragraph [0033] the present inventors surprisingly found that extending the injector tube 50 in the low pressure nozzle system a distance beyond the end of the throat up to 1/3 of the length of the diverging section resulted in an increase in the deposition efficiency of the kinetic spray nozzle, which was unexpected. Such a result is not obvious given the disclosures of the cited references. In summary, independent claim 5 includes numerous limitations neither found in or made obvious in view of the cited references taken alone or in combination thus the rejection of claims 11-16, which depend from independent claim 5 based on the cited references is improper and must be withdrawn.

It is believed that this application now is in condition for allowance. Further and favorable action is requested.

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